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VALUES OF VARIOUS NEW FEEDS FOR DAIRY COWS

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CONTENTS

	Page		Page
Plan of the experimental work	1	Potato silage compared with corn silage	7
Fish meal compared with cottonseed meal	2	Apple-pectin pulp compared with beet pulp	8
Peanut feed compared with cottonseed meal	3	Hydrolyzed sawdust compared with corn meal	9
Potato meal compared with corn meal	5	Cane molasses as a supplementary feed	12
Velvet-bean meal compared with cottonseed meal	6	Summary	14
Sweet-potato meal compared with corn meal	7		

PLAN OF THE EXPERIMENTAL WORK

During the last few years the Dairy Division has conducted feeding trials at its experiment farm, Beltsville, Md., with a number of feedstuffs in order to determine their values as feeds for dairy cows. Some of these feeds have only recently been prepared in a commercial way.

The same general plan was used in conducting most of the experiments here reported. A certain number of cows of at least average production were selected and divided into two equal groups balanced as nearly as possible with reference to production, breed, and body weight. Special care was taken to select only such cows as would be likely to continue throughout the experiment without undue diminution in milk flow due to advanced stage of lactation or approaching parturition. The reversal system of feeding was used, usually allowing 10 days for the cows to become accustomed to their rations and the same length of time when the rations were reversed. The length of the experimental periods varied according to the feeding materials available and the length of time it was thought the cows would give milk before beginning to go dry.

In every case the feed under investigation was compared with some standard feed as similar in composition as could be obtained, and one which might be replaced by the new feed if found satisfactory. Since the system of measuring the results of feeding experiments is not sensitive to slight changes in the ration, the general practice

[1] Mr. Hale resigned in March, 1917, and Mr. McNulty in August, 1919.

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in these experiments was to use the largest practicable quantity of the new feed. While the protein content of the rations varied somewhat, care was taken to have the minimum well above the quantity generally regarded as sufficient. A certain number of pounds of concentrates was fed for each pound of butterfat produced, the adjustment being made every 10 days.

All the milk was weighed as soon as drawn, and composite samples for two or more days during each 10-day period were taken for butterfat determinations. Body weights were taken at the beginning and end of the experimental periods for at least three consecutive days and as often at other times as necessary to control the live weights so that the gains would be approximately the same for both groups at the conclusion of the experiment.

In feeding experiments it is rather difficult to control all the disturbing factors so that a direct comparison can be made between two feeds at the end of the experiment. Usually there are at least three variable factors—milk, butterfat, and body weight. Provided the experiment runs for a sufficient length of time, the body weights can usually be adjusted by raising or lowering the quantities of one or both of the two feeds being compared. Owing to the variation in the butterfat content of milk it is evident that the more accurate basis of calculation is the pounds of butterfat rather than the pounds of milk.

After considerable thought it was decided to feed the two groups of cows in these experiments so that not only would the gains in body weight at the conclusion of each experiment be comparable, but each group would also have received the same amounts of feeds, other than those being compared, for each pound of fat produced. In this way a direct comparison of the two feeds on the basis of butterfat production was made possible.

FISH MEAL COMPARED WITH COTTONSEED MEAL

The fish meal used in this experiment was prepared under the direction of F. C. Weber, Bureau of Chemistry. It was made from the waste in the canning of sardines by pressing out most of the oil and then drying and grinding the residue. The fish meal was fed to six cows for two periods of 70 days each in comparison with cottonseed meal. The other concentrates used in the ration were equal parts of corn meal and wheat bran. Alfalfa hay was fed to each cow at the rate of 6 pounds a day with as much corn silage as would be consumed without waste. Fish meal and cottonseed meal were each supplied at the rate of 3 pounds per cow daily until near the end of the experiment, when it became evident that the fish meal was superior to the cottonseed meal. The allowance of fish meal was then reduced and that of cottonseed meal increased for the purpose of controlling the live weight.

Table 1 gives the analyses of the feeds used in this experiment; Table 2 shows the production, feed, and gain in body weight; and Table 3, the ratio of feed consumed to butterfat produced.

TABLE 1.—*Composition of fish meal and cottonseed meal*

Feed	Moisture	Ash	Crude protein	Albuminoid protein	Ether extract	Crude fiber	Nitrogen-free extract
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Fish meal	5. 82	17. 60	61. 07	----------	15. 51	----------	----------
Cottonseed meal	7. 12	6. 30	38. 65	37. 56	7. 89	9. 97	30. 07

TABLE 2.—*Comparative results of feeding fish meal and cottonseed meal*

Group	Quantity of feed					Yield		Gain in body weight
	Grain	Fish meal	Cotton-seed meal	Alfalfa hay	Corn silage	Milk	Butter-fat	
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Fish-meal groups	2, 017	930. 9	----------	2, 026	10, 410	7, 829. 5	350. 22	99. 5
Cottonseed-meal groups	2, 030	----------	1, 168	2, 019	10, 019	7, 754. 1	354. 53	75. 5

TABLE 3.—*Feed consumed for each pound of butterfat produced in fish-meal experiment* [1]

Group	Grain	Fish meal	Cotton-seed meal	Alfalfa hay	Corn silage
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Fish-meal groups	5. 76	2. 66	----------	5. 78	29. 7
Cottonseed-meal groups	5. 73	----------	3. 29	5. 69	28. 3

[1] This experiment indicates that 1 pound of fish meal is equal to about 1.24 pounds of cottonseed meal.

It will be noted that the fish-meal groups produced slightly more milk but a trifle less butterfat, while the grain and alfalfa hay were practically the same for each group. The fish-meal groups consumed almost 400 pounds more silage, but to offset this they gained 24 pounds more in body weight than the other groups. Perhaps it may be assumed that one will about balance the other, and if so we have a direct comparison between the fish meal and cottonseed meal. Apparently, for dairy cows, the fish meal is worth pound for pound 20 or 25 per cent more than cottonseed meal.

Fish meal is not so palatable as cottonseed meal, though no difficulty was experienced in getting the cows to eat all that was offered them. No bad effects on the physical condition of the cows were observed. The flavor of the milk apparently was not impaired in any way either by exposing milk to the odor of fish meal or by feeding the cows 4 pounds of the fish meal one hour before milking. While it can not be positively stated that fish meal has no bad effect whatever on the flavor and odor of milk, such effect, if any, is so slight as to be unnoticed by the ordinary consumer.

PEANUT FEED COMPARED WITH COTTONSEED MEAL

The residue from cold-pressed unhulled peanuts furnished by the Bureau of Chemistry was fed in comparison with cottonseed meal to six cows for two periods of 70 days each. The other concentrates used in the ration were equal parts corn meal and wheat bran.

Alfalfa hay was fed to each cow at the rate of 10 pounds daily, and as much silage as would be consumed without waste of silage or hay. Peanut feed and cottonseed meal were each fed at the rate of 3 pounds per cow daily until within 20 days of the close of the experiment, when it became evident that the cows receiving cottonseed meal were gaining in weight considerably more than the other group. To remedy this condition as far as possible the cottonseed meal was discontinued with one group, and 5 pounds of peanut feed per cow per day were fed to the other group, but even these measures were not fully effective and the result was that the three cottonseed-meal fed cows gained 79 pounds more than the three peanut-feed fed cows. The adjustment of the rations should have begun earlier. Tables 4, 5, and 6 illustrate this experiment.

TABLE 4.—*Composition of peanut feed and cottonseed meal*

Feed	Moisture	Ash	Crude protein	Albuminoid protein	Ether extract	Crude fiber	Nitrogen-free extract
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Peanut feed	5.91	3.56	27.25	26.01	7.11	26.86	29.31
Cottonseed meal	6.96	6.50	39.13	37.50	7.03	9.84	30.54

TABLE 5.—*Comparative results of feeding cottonseed meal and peanut feed*

Group	Quantity of feed					Yield		Gain or loss in body weight
	Grain	Peanut meal	Cotton-seed meal	Alfalfa hay	Corn silage	Milk	Butter-fat	
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Peanut-feed groups	2,076	1,414.5		3,806	10,359	9,943.3	432.25	—61.4
Cottonseed-meal groups	2,148		1,071.5	3,953	10,732	10,334.4	445.69	17.2

TABLE 6.—*Feed consumed for each pound of butterfat produced in peanut-feed experiment* [1]

Group	Grain	Peanut feed	Cotton-seed meal	Alfalfa hay	Corn silage
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Peanut-feed groups	4.80	3.27		8.81	24.0
Cottonseed-meal groups	4.82		2.40	8.87	24.1

[1] This experiment indicates that 1 pound of cottonseed meal is equal to about 1.36 pounds of peanut feed.

Since the cottonseed-meal groups gained more than the other groups, the relative value assigned to the peanut feed must be considered as representing the maximum value. Apparently with these feeds the protein content is a fairly reliable indication of the feeding value. The peanut feed is very palatable and there seems to be no reason why it should not come into general use as a feed for dairy cows.

Since this experiment was conducted, much peanut meal is being made from the hulled nuts and runs as high in protein as cottonseed meal. Until further tests are made, such meal may be assumed to be equal in feeding value to cottonseed meal.

POTATO MEAL COMPARED WITH CORN MEAL

Potato meal was prepared by Dr. H. C. Gore, of the Bureau of Chemistry, by grinding the potatoes to pulp, then pressing and drying. The drying was rapid enough to prevent spoilage of any kind, but the heat used was not sufficient to cook the starch. This material was fed in comparison with corn meal to six cows for two periods of 70 days each. The grain mixture fed to one group consisted of potato meal 2 parts, wheat bran 1 part, and cottonseed meal 1 part; that fed to the other group was the same except that corn meal replaced the potato meal. Clover hay was fed to each cow at the rate of 8 pounds a day with such quantities of silage as would be consumed.

Although an attempt was made to adjust the live weights beginning 30 days before the conclusion of the experiment, still the corn-meal groups gained 90 pounds more than the potato-meal groups. In conducting further tests it would be better to begin with the assumption that potato meal is not so efficient as corn meal and arrange the rations accordingly. Since there is no way of correcting accurately for this difference of gain in weight, the only thing that can be done is to state that whatever results were obtained are more favorable to that feed producing the larger gains than the figures on comparative values show. Tables 7, 8, and 9 give the figures on this experiment.

TABLE 7.—*Composition of potato meal and corn meal*

Feed	Moisture	Ash	Crude protein	Albuminoid protein	Ether extract	Crude fiber	Nitrogen-free extract
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Potato meal	11.06	1.11	2.51	1.94	0.10	1.85	83.37
Corn meal	8.73	1.45	8.96	6.39	5.13	2.69	73.04

TABLE 8.—*Comparative results of feeding potato meal and corn meal*

Group	Quantity of feed						Yield		Gain in body weight
	Corn meal	Potato meal	Wheat bran	Cottonseed meal	Clover hay	Corn silage	Milk	Butterfat	
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Potato-meal groups		2,019	795	795	2,906	7,554	8,867.7	305.33	18
Corn-meal groups	1,766		883	883	3,225	8,448	9,642.1	341.06	108

TABLE 9.—*Feed consumed for each pound of butterfat produced, in potato-meal experiment* [1]

Group	Corn meal	Potato meal	Wheat bran	Cottonseed meal	Clover hay	Corn silage
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Potato-meal groups		6.61	2.60	2.60	9.52	24.74
Corn-meal groups	5.18		2.59	2.59	9.46	24.77

[1] This experiment indicates that 1 pound of corn meal is equal to about 1.28 pounds potato meal.

Taking into consideration the difference of gain in weight the potato meal is really less efficient than shown.

VELVET-BEAN MEAL COMPARED WITH COTTONSEED MEAL

The Bureau of Plant Industry furnished about 1,500 pounds of hulled velvet beans for experimental feeding. The beans were ground and fed in comparison with choice cottonseed meal to six cows, two groups of three each, for two periods of 50 days each. One lot received 4 pounds of velvet-bean meal with enough corn meal and wheat bran, equal parts, to bring the total grain ration up to 8 pounds for each pound of fat produced. The other lot was fed the same except that cottonseed meal was substituted for velvet-bean meal. The remainder of the ration consisted of from 6 to 8 pounds of alfalfa hay and 15 to 35 pounds of corn silage.

The tendency of both groups to gain in live weight when fed cottonseed meal necessitated a reduction in the allowance of this concentrate. This condition caused a much lower total consumption of cottonseed meal as compared with velvet-bean meal. Velvet-bean meal is not nearly so palatable as cottonseed meal. In most instances the velvet-bean meal composed only about half of the total grain allowance. When the mixture contained less of the velvet-bean meal some cows consumed their grain allowances somewhat more readily. It was seldom, however, that any cow consumed 4 pounds of velvet-bean meal daily, and some even failed to eat 2 pounds daily. During the last 10 days two cows were fed 6 pounds of grain with 4 pounds of the velvet-bean meal. In neither case was all the velvet-bean meal consumed, and one of the two cows invariably refused from 1 to 2 pounds of the meal.

Since it appears that from 2 to 4 pounds of velvet-bean meal is all that an average-producing cow will consume, the following figures on the relative value of velvet-bean meal are true only when from 2 to 4 pounds are fed. As a rule the ground velvet-bean meal was fed dry. Allowing the meal to soak did not appear to make it any more palatable. Tables 10 and 11 give the results of this experiment.

TABLE 10.—*Comparative results of feeding velvet-bean meal and cottonseed meal*

Group	Quantity of feed					Yield		Gain in body weight
	Velvet-bean meal	Cotton-seed meal	Corn meal and wheat bran	Alfalfa hay	Silage	Milk	Butter-fat	
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Velvet-bean meal groups	835. 7	---------	803. 7	2, 015	7, 718	4, 599. 2	199. 90	16
Cottonseed-meal groups	---------	592. 0	908. 0	2, 093	8, 203	4, 789. 4	217. 76	111

TABLE 11.—*Feed consumed for each pound of butterfat produced in velvet-bean experiment* [1]

Group	Velvet-bean meal	Cotton-seed meal	Grain mixture	Alfalfa hay	Corn silage
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Velvet-bean-meal groups	4. 18	---------	4. 02	10. 08	38. 6
Cottonseed-meal groups	---------	2. 72	4. 17	9. 61	37. 7

[1] This experiment indicates that 1 pound cottonseed meal is equal to about 1.54 pounds velvet-bean meal.

Since the proportions, as shown, do not take into account the difference in gain in live weight, they may be regarded as indicating a maximum, if not an excessive, value for velvet-bean meal.

SWEET-POTATO MEAL COMPARED WITH CORN MEAL

Sweet-potato meal was prepared by Dr. H. C. Gore, of the Bureau of Chemistry, from sweet potatoes of standard varieties grown at the Arlington Experiment Farm. The sweet potatoes, after being shredded with sugar-beet knives, were dried and ground. The meal was fed in comparison with corn meal to four cows in groups of two cows each, for two periods of 50 days each. The grain mixture used for one group consisted of sweet-potato meal 3 parts, bran 1 part, oats 1 part, and cottonseed meal 1 part; that used for the other group was the same except that corn meal was substituted for the sweet-potato meal. This was fed at the rate of about 10 pounds to each pound of fat produced. The remainder of the ration consisted of alfalfa hay 8 pounds and corn silage 25 to 30 pounds. The results are shown in Table 12.

TABLE 12.—*Comparative results of feeding sweet-potato meal and corn meal*

Group	Quantity of feed					Yield		Gain or loss (−) in body weight
	Sweet-potato meal	Corn meal	Grain mixture	Alfalfa hay	Corn silage	Milk	Butter-fat	
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Sweet-potato meal groups	863. 0	---------	863. 1	1, 592	4, 943	3, 960. 2	157. 04	−11
Corn-meal groups	---------	767. 5	865. 5	1, 596	5, 226	4, 083. 2	160. 89	−64

It will be noted in Table 12 that the cows fed sweet-potato meal yielded slightly less milk and butterfat, consumed a few hundred pounds less corn silage, and showed 53 pounds less loss in live weight; and that 863 pounds of sweet-potato meal were consumed as against 767.5 pounds of corn meal. While the number of cows is too small to permit satisfactory conclusions, the indications are that sweet-potato meal is about as valuable as corn meal, and until more extensive experiments are conducted the chemical analysis will probably answer as a fairly reliable guide in estimating the nutritive value of the meal. No difference was noted in the palatability of the two meals.

POTATO SILAGE COMPARED WITH CORN SILAGE

The potato silage used in this experiment was prepared by Dr. H. C. Gore, of the Bureau of Chemistry. The potatoes after being washed were passed through a machine fitted with steel pins on a cylinder, which tore them into small pieces. The silage was preserved in two small silos and kept in good condition, but was too soft to bear the weight of a person.

The corn silage fed in comparison was of first-class quality except for 25 days of the feeding, during which time 5-year-old silage was used. This was hardly so palatable as that kept for only one or two years. Six cows were fed for two periods of 30 days each. Silage

was fed at the rate of 30 to 35 pounds per cow per day and alfalfa hay at the rate of 6 pounds. The grain mixture consisted of corn-and-cob meal 250 pounds, wheat bran 200 pounds, and cottonseed meal 100 pounds, and was fed at the rate of from 7 to 10 pounds a day. Table 13 gives the results of the experiment.

TABLE 13.—*Comparative results of feeding potato silage and corn silage*

Group	Quantity of feed				Yield		Gain in body weight
	Grain	Hay	Potato silage	Corn silage	Milk	Butter-fat	
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Potato-silage groups	1,588	1,080	5,700	----------	3,269.2	157.73	157
Corn-silage groups	1,590	1,080	----------	5,700	3,330.8	163.57	138

The corn-silage groups produced slightly more milk and butter-fat but gained less in weight. The differences, however, are so small that the two silages may be considered of equal value for feeding dairy cows. The potato silage seemed to be as palatable as the best corn silage and more so than the corn silage that was 5 years old.

APPLE-PECTIN PULP COMPARED WITH BEET PULP

Dried apple-pectin pulp, a by-product in the extraction of pectin from apple pomace, was furnished by the Bureau of Chemistry for use in the feeding experiment reported below. Since the dried pectin pulp was similar to dried beet pulp in composition and in being able to absorb water readily, it was considered best to use beet pulp as the feed with which to make comparison. Six cows were fed for two 30-day periods.

Both apple-pectin pulp and beet pulp were fed wet with 3 pounds of water to each pound of dry pulp. The pulp soaked from one feeding to the next and 40 pounds of the wet pulp per day were offered to each cow. The remainder of the ration consisted of alfalfa hay, about 10 pounds, and a grain mixture composed of corn meal 100 pounds, ground oats 100 pounds, wheat bran 100 pounds, linseed meal 50 pounds, and cottonseed meal 50 pounds, fed at the rate of from 10 to 12 pounds for each pound of fat produced. The feed consumed and the production are given in Table 14.

TABLE 14.—*Comparative results of feeding apple-pectin pulp and beet pulp*

Group	Quantity of feed			Yield		Gain or loss (−) in body weight
	Wet pulp	Alfalfa hay	Grain	Milk	Butter-fat	
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Pectin-pulp groups	6,759	1,785	1,627.6	4,375.7	152.93	−67
Beet-pulp groups	7,200	1,800	1,839.2	4,976.5	171.86	109

The pectin-pulp groups ate less of the pulp, produced less, and lost in weight, whereas the beet-pulp groups gained in weight. Neither is the pectin pulp so palatable as the beet pulp, as three of the six cows refused part or all of the pectin pulp at some time or other during the experiment, while the beet pulp was at no time refused. The data show that the apple-pectin pulp is not so valuable pound for pound as beet pulp for dairy cows, although no exact comparison of values is possible.

HYDROLYZED SAWDUST COMPARED WITH CORN MEAL

Hydrolyzed sawdust furnished by the Forest Service from its laboratory at Madison, Wis., was fed in comparison with corn meal. This sawdust was thought to possess some nutritive value on account of the changes brought about in the cellulose by the treatment with dilute acids, which would make it more available to the animal. While a preliminary experiment conducted previously at this station indicated that the sawdust was somewhat lacking in palatability and contained a large proportion of material of no feeding value, it was nevertheless thought advisable to give it a more thorough test.

The Wisconsin Agricultural Experiment Station, as a result of two trials with the hydrolyzed sawdust, found that it could form one-fourth to one-third of the concentrate mixture and that it could be substituted for corn or barley in the mixture without affecting the normal milk flow. The cows maintained their live weight slightly better when receiving the sawdust. The nutritive values of the sawdust as compared with corn and barley are not stated in the report of those experiments.[3]

In the experiment here reported two Holstein and four Jersey cows were divided into two groups balanced as nearly as possible as regards breed, production, body weight, and stage of lactation. The production of these cows at the beginning of the test was approximately as shown in Table 15.

TABLE 15.—*Production of cows at beginning of hydrolyzed-sawdust experiment*

Cow No.	Milk per day	Butterfat in milk
	Pounds	*Per cent*
227	27	3.2
459	21	4.0
411	19	4.5
441	22	4.8
416	21	4.8
257	38	3.4

The cows were fed by the reversal method for two periods of 70 days each, 10 days being allowed at the beginning and at the end of the first half for the cows to become accustomed to the change in the rations.

Since it was thought that corn would be the material most likely to be replaced by the sawdust in case of its coming into use as a dairy feed, the rations for the two groups of cows were so prepared and fed that 2 pounds of sawdust replaced 1 pound of corn meal.

[3] Address by Prof. F. B. Morrison before the American Society of Animal Production, 1921.

One ration consisted of the following mixture: 100 pounds corn meal, 200 pounds ground oats, 100 pounds wheat bran, 50 pounds linseed meal, and 50 pounds cottonseed meal, fed at the rate of 10 pounds for each pound of fat produced. The other ration consisted of 200 pounds sawdust, 200 pounds ground oats, 100 pounds wheat bran, 50 pounds linseed meal, and 50 pounds cottonseed meal, fed at the rate of 12 pounds for each pound of fat produced. Corn silage and alfalfa hay were fed to both groups in such quantities as would be consumed without waste.

For 2 days during each 10-day period a composite sample of each cow's milk was tested for fat, and from this and the quantity of milk produced for the 10 days an estimate was made of the grain to be fed each cow for the succeeding 10 days.

The plan was to keep the gains in body weight of the two groups nearly the same by varying only the corn meal and sawdust, and to feed the cows so that at the conclusion of the experiment the ingredients of the ration, except corn meal and sawdust, would be the same per pound of butterfat produced. A direct comparison of corn meal and sawdust would thus be made possible. The experiment did not run as planned, because too great value was assumed for the sawdust in the beginning and because of its unpalatable nature. When it became evident from the daily live weights that the sawdust group should be fed more in order to bring the gains up to those of the other group, it was found impracticable to feed sufficient sawdust to bring this about, and as a result the other ingredients of the rations than corn meal and sawdust varied somewhat.

The production of Cow 411 decreased so rapidly near the end of the first half that she was dropped from the experiment. Cow 227 went off feed about 8 days before the close of the experiment. In order to avoid discarding a considerable amount of good data on the other cows her production for the last 10 days was assumed. Cow 411 was receiving the sawdust ration when she began to go dry, and Cow 227 was receiving the other ration at the time of her digestive disturbance.

After Cow 411 went dry one of the groups contained 3 cows and the other 2 cows. Since the comparison of 2 cows with 3 introduces certain inaccuracies, Cows 227 and 459 were compared with Cows 416 and 257, and again with Cows 441 and 257. The results are shown in Tables 16, 17, 18, and 19.

TABLE 16.—*Comparative results of feeding hydrolyzed sawdust and corn meal (Cows 227 and 459 compared with Cows 416 and 257).*

Period	Sawdust groups							
	Cow No.	Quantity of feed				Yield		Gain or loss (−) in body weight
		Grain mixture	Alfalfa hay	Corn silage	Sawdust	Milk	Butterfat	
		Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
First period	227	415.8	525	2,227.5	247.9	1,367.9	45.14	50
	459	377.3	340	1,849.5	227.7	1,148.1	49.75	27
Second period	416	383.2	352	1,676.0	262.6	860.6	49.39	−4
	257	466.4	522	2,273.0	323.2	1,587.3	60.37	−2
Total		1,642.7	1,739	8,026.0	1,061.4	4,963.9	204.65	71

TABLE 16.—*Comparative results of feeding hydrolyzed sawdust and corn meal (Cows 227 and 459 compared with Cows 416 and 257)*—Continued.

Period	Cow No.	Corn-meal groups: Quantity of feed: Grain mixture	Alfalfa hay	Corn silage	Corn meal	Yield: Milk	Butterfat	Gain in body weight
		Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
First period	416	456. 0	346	1, 706	87. 2	1, 123. 3	57. 56	47
	257	634. 4	526	2, 252	119. 8	2, 119. 7	77. 13	30
Second period	227	303. 7	524	2, 305	58. 2	1, 022. 5	36. 16	3
	459	435. 5	353	1, 801	80. 4	947. 4	55. 16	19
Total		1, 829. 6	1, 749	8, 064	345. 6	5, 212. 9	226. 01	99

TABLE 17.—*Amount of feed consumed for each pound of butterfat produced in experiment reported in Table 16* [1]

Group	Grain mixture	Alfalfa hay	Corn silage	Sawdust	Corn meal
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Sawdust groups [2]	8. 03	8. 50	39. 22	5. 19	----------
Corn-meal groups	8. 10	7. 74	35. 68	----------	1. 53
Difference, sawdust over corn meal	−. 07	. 76	3. 54	----------	----------
Difference in digestible nutrients	−. 05	. 39	. 63	----------	----------

[1] Comparing the two groups, 1.53 pounds corn meal are equal to 1.16 pounds corn meal plus 5.19 pounds sawdust. Therefore, 0.37 pound corn meal equal 5.19 pounds sawdust, and 1 pound corn meal equals 14 pounds sawdust.

[2] Excess nutrients received by sawdust groups, 0.97 pound, which is equivalent to 1.16 pounds corn meal.

TABLE 18.—*Comparative results of feeding hydrolyzed sawdu st and corn meal (Cows 227 and 459 compared with Cows 441 and 257).*

Period	Cow No.	Sawdust groups: Quantity of feed: Grain mixture	Alfalfa hay	Corn silage	Sawdust	Yield: Milk	Butterfat	Gain or loss(−) in body weight
		Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
First period	227	415. 8	525	2, 227. 5	247. 9	1, 367. 9	45. 14	50
	459	377. 3	340	1, 849. 5	227. 7	1, 148. 1	49. 75	27
Second period	441	485. 3	404	1, 715. 0	244. 6	1, 019. 3	60. 33	9
	257	466. 4	522	2, 273. 0	323. 2	1, 587. 3	60. 37	−2
Total		1, 744. 8	1, 791	8, 065. 0	1, 043. 4	5, 122. 6	215. 59	84

Period	Cow No.	Corn-meal groups: Quantity of feed: Grain mixture	Alfalfa hay	Corn silage	Corn meal	Yield: Milk	Butterfat	Gain in body weight
		Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
First period	441	552. 4	405	1, 856	101. 8	1, 233. 2	69. 32	22
	257	634. 4	526	2, 252	119. 8	2, 119. 7	77. 13	30
Second period	227	303. 7	524	2, 305	58. 2	1, 022. 5	36. 16	3
	459	435. 5	353	1, 801	80. 4	947. 4	55. 16	19
Total		1, 926. 0	1, 808	8, 214	360. 2	5, 322. 8	237. 77	74

TABLE 19.—*Amount of feed consumed for each pound of butterfat produced, in experiment reported in Table 18* [1]

Group	Grain mixture	Alfalfa hay	Corn silage	Sawdust	Corn meal
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Sawdust groups [2]	8.09	8.31	37.41	4.84	----------
Corn-meal groups	8.10	7.60	34.55	----------	1.51
Difference, sawdust over corn meal	−.01	.71	2.86	----------	----------
Difference in digestible nutrients	−.01	.37	.51	----------	----------

[1] Comparing the two groups, 1.51 pounds of corn meal are equal to 1.04 pounds corn meal plus 4.84 pounds sawdust. Therefore, 0.47 pound corn meal equals 4.84 pounds sawdust, and 1 pound corn meal equals 10 pounds sawdust.

[2] Excess nutrients received by sawdust groups, 0.87 pound, which is equivalent to 1.04 pounds corn meal.

It will be noted in the foregoing tables that the sawdust fed to cows produced less of both milk and butterfat, and the result is much the same whether the groups containing Cow 416 or those containing Cow 441 are used in making the computation.

In the statement of feed consumed for each pound of butterfat produced it will be seen that more than 3 pounds of sawdust were consumed for each pound of corn meal.

Taking into consideration the excess of other ingredients consumed by the sawdust groups and assuming the digestible nutrients of these feeds to be as valuable as an equal weight of digestible nutrients in corn meal, the sawdust is shown to have a value from one-fourteenth to one-tenth as great as that of corn meal. It is thought, however, by some that the comparison of feeds on the basis of the content of digestible nutrients is not so accurate as by Armsby's energy values. While the energy values are not so commonly used as the other method, it is of interest to see what the results would be when calculated according to Armsby. Using Cow 416 the excess energy consumed by the sawdust groups would be contained in 0.99 pound corn meal instead of 1.16, which would make 1 pound of corn meal equal to 8.24 pounds of sawdust. By using Cow 441 the excess is contained in 0.81 pound corn meal instead of 1.04, which would make 1 pound of corn meal equal to 6.91 pounds of sawdust. By the Armsby method, therefore, the hydrolyzed sawdust is estimated to have a nutritive value about one-seventh or one-eighth that of corn meal.

This experiment bears out preliminary work which showed the sawdust to lack palatability and to contain a large proportion of material of no feeding value. Even figuring the sawdust at the maximum nutritive value as shown by this experiment, it is still too poor a feed to justify its transportation for any considerable distance, not to mention the cost of manufacture.

While there is no doubt that this chemically treated sawdust can be used in limited quantities as a feed for dairy cows, it possesses so little nutritive value that its use is inadvisable.

CANE MOLASSES AS A SUPPLEMENTARY FEED

In the feeding of cows on advanced-registry test, molasses is often used to make the ration more palatable and thus induce greater consumption, as well as for the nutriment in the molasses itself. Molas-

ses is inconvenient to feed, attracts flies, and, considering the nutrients it contains, is expensive. The question arises, therefore, whether it is advisable to feed molasses to cows that will normally take the required amount of feed to maintain production without molasses. Tables 20, 21, and 22 are drawn from an experiment designed to answer this question.

Eight cows on advanced-registry test were divided into two groups closely balanced as regards production. The reversal method was used for two periods of 40 days each, 10 days of which were allowed for the cows to become accustomed to their rations. One group received the usual feed plus 1½ pounds per cow per day of molasses diluted with water, the solution being used in moistening the dried beet pulp. The other group received no molasses. No attempt was made to regulate the other constituents of the ration. The result as shown in Table 20 was that the molasses-fed group consumed more feed and produced more milk and butterfat, but the increase was not economical.

TABLE 20.—*Feeds consumed when molasses was added to the ration and cows were allowed to eat what they would of other feeds*

Group	Quantity of feed					Yield	
	Grain	Alfalfa hay	Corn silage	Beet pulp	Molasses	Milk	Butterfat
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Groups with molasses	2,778	3,392	4,074	1,290	360	6,364.0	283.76
Groups without molasses	2,771	3,120	4,006	1,260		6,184.6	275.28
Difference in favor of molasses	7	272	68	30	360	179.4	8.48

In return for 7 pounds of grain, 272 pounds of hay, 68 pounds of silage, 30 pounds of beet pulp, and 360 pounds of molasses, the increase in yield was only 179.4 pounds of milk and 8.48 pounds of butterfat. This is not enough to pay for the molasses alone. It should be noted that in this experiment the molasses was added to a ration already more than sufficient to maintain production according to the feeding standards.

In another experiment with the same number of cows and for periods of the same length, 1.1 pounds of molasses a day were added to the ration of each cow, the other constituents of the ration remaining practically the same for both groups. As in the preceding experiment, the ration according to standards was ample for the quantity of milk produced, without the molasses.

TABLE 21.—*Results of adding molasses to a ration not otherwise appreciably changed*

Group	Quantity of feed					Yield	
	Grain	Hay	Silage	Beet pulp	Molasses	Milk	Butterfat
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Groups with molasses	3,101.0	3,192	3,448	1,257	264	7,570.9	345.21
Groups without molasses	3,069.5	3,191	3,458	1,257	0	7,480.8	352.99
Difference in favor of molasses	31.5	1	−10	0	264	90.1	−7.78

The addition of 264 pounds of molasses to an already satisfactory ration resulted in production of 90.1 pounds more milk and 7.78 pounds less fat. The extra milk in this case, as in the preceding, does not cover the cost of the molasses.

It was thought probable that results more favorable to molasses might be obtained by replacing a portion of the ration with molasses rather than by feeding the molasses in addition to other feeds. Accordingly, in another experiment (Table 22), 1.1 pounds of hominy feed were replaced with an equal weight of molasses, the experiment otherwise being exactly like the preceding.

TABLE 22.—*Comparison of molasses and hominy feed in ration otherwise identical*

Group	Quantity of feed						Yield		
	Grain	Hay	Silage	Beet pulp	Molasses	Hominy feed	Milk	Butterfat	Gain in body weight
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Groups fed molasses	3,202.5	2,989	3,448	1,255.5	264		7,991.9	346.82	242
Groups fed hominy feed	3,202.5	2,998	3,448	1,255.5		264	8,244.2	351.74	205
Difference in favor of hominy feed							252.3	4.92	−37

The molasses-fed cows produced 252.3 pounds less milk and 4.92 pounds less butterfat but gained a little more in body weight. Apparently the molasses is slightly less valuable pound for pound than hominy feed, though probably the digestible nutrients in molasses are as efficient for milk production as an equal weight of digestible nutrients in hominy feed.

In no one of the three molasses experiments is there evidence of any advantage in feeding molasses that is at all commensurate with the extra trouble of handling it, to say nothing of the extra cost. Molasses, no doubt, is of value for certain uses, such as rendering feeds of poor quality more palatable, inducing greater consumption of feed by exceptionally high producers, or for use by cows naturally lacking in digestive capacity.

SUMMARY

Fish meal, though not so palatable as cottonseed meal, was found to be worth pound for pound 20 or 25 per cent more than prime cottonseed meal.

Peanut feed containing 27.25 per cent crude protein possesses a nutritive value not exceeding 74 per cent of that of prime cottonseed meal. It is thought that the protein content affords a fairly reliable guide in estimating the value of this feed in comparison with cottonseed meal.

Potato meal is worth not more than 78 per cent as much as corn meal.

The maximum value that can be assigned to velvet-bean meal is 65 per cent that of cottonseed meal.

Sweet-potato meal appears to be almost as valuable as corn meal as a feed for dairy cows.

Potato silage and corn silage were found to possess about the same feeding value.

Apple-pectin pulp compared with dried beet pulp was found to be less palatable and less efficient as a feed.

Hydrolyzed sawdust is unpalatable, contains but little nutriment, and can be fed only in small quantities. The maximum value that can be assigned to the sawdust is 14.5 per cent of that of corn meal.

Supplementing with cane molasses a ration already suitable is not economical. Compared with an equal weight of hominy feed the molasses appears slightly less valuable. Molasses renders feeds of poor quality more palatable and induces a greater consumption of nutrients, a matter of importance in feeding exceptionally high-producing cows.

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